Technology Demonstration Fact Sheet
Seal Seam Sack Suits

SUMMARY

From October 1996 to August 1997, a total of seven different personal protective clothing (six disposable [innovative] and one reusable cotton [baseline]) were demonstrated for contamination protection, safety, and comfort under the C Reactor Large-Scale Technology Demonstration Project (LSDP). Los Alamos National Laboratory (LANL) Industrial Hygiene and Safety Group Research and Development was contracted to work with the Hanford C Reactor Project Industrial Safety and Hygiene Department to perform heat stress and temperature measurements in an environmental chamber and to conduct two fabric penetration aerosol tests--one test on the fabric and the other test while the subject wore the protective clothing. Testing was performed to examine the suits objectively and scientifically to assess the parameters indicated above. Concurrent qualitative results were gathered at the C Reactor demonstration from interviews of decontamination and decommissioning (D&D) workers wearing similar suits to subjectively determine the field comfort level of the suits.

Four different brands of disposable suits and one brand of reusable cotton suit were assessed and demonstrated. All disposable suits were water-resistant and vapor-permeable, except for one suit that was water-resistant and vapor-impermeable.

The suits assessed at LANL included the following:
- Comfort Guard 150
- Frham KoolSuit
- Kappler ProShield I
- Kappler ProShield II
- Kappler NuFab
- Kappler Tyvek
- Copiah Creek (cotton).

The goal of this demonstration was to examine the disposable suits effectiveness, level of protection, cost, and comfort level (the worker's physiological heat capacity) against the baseline cotton suit.

INNOVATIVE/BASELINE TECHNOLOGY DESCRIPTION

The demonstration criteria were designed by the C Reactor Industrial Safety and Hygiene Officer for heat stress assessments that were conducted by the LANL Research and Development group. The tests were conducted on all six suits using three different sizes of personnel in two environmental conditions. The environmental chamber was 3.1 m by 3.1 m (10 ft by 10 ft), with controls for humidity and temperature. The tests were conducted at 35°C (95°F) with a relative humidity of 70%, and at 0°C (32°F) with a relative humidity of 50%.

Fabric aerosol penetration assessments were conducted using equipment developed by the LANL Research and Development group. This equipment is capable of testing all types of material equally using an established change in pressure (DP) across the material sample. The flow through the fabric sample may vary as the DP is maintained by the equipment. This method allows nonpermeable materials to be assessed equally with more loosely woven materials. Aerosol penetration assessment was performed simultaneously with the heat stress testing. Sample probes were inserted inside the suits, and the aerosol penetration was monitored. Concurrently at C Reactor, the D&D workers wore five of these suits during normal daily activity. At the end of each task, the D&D workers were asked a series of specific questions regarding these suits, and their responses were recorded by the C Reactor Industrial Safety and Hygiene Officer. The majority of the worker responses were positive.

The Copiah Creek suit (baseline) is constructed of white cotton duct material; the KoolSuit of yellow, nonwoven breathable laminate; the Kappler ProShield of white, nonwoven laminate point-bonded material; the Kappler NuFab of yellow, nonwoven material with an internal membrane; the Kappler Tyvek of polyethylene-coated Tyvek (impermeable) material; and the Comfort Guard 150 of a yellow, nonwoven material. Some of the material descriptions are based on examinations by the C Reactor Project and LANL because the actual material construction is proprietary.

DEMONSTRATION DESCRIPTION

Before contracting with LANL, many clothing test characteristics were evaluated, which included the following:

- Types of hazards posed as a result of exposure to a contaminant and its consequences
- Degree of protection provided by the protective clothing
- Chemical protection limitations
- Donning and doffing procedures
- Methods of sealing seam areas
- Clothing decontamination procedures.
- Other considerations included the following:
- Durability - Does the material have sufficient strength to withstand the physical stress of the task(s) at hand? Will the material resist tears, punctures, and abrasions? Will the material withstand repeated use after contamination and decontamination (for baseline)?
- Flexibility - Will the chemical protective clothing interfere with the workers ability to perform assigned tasks?

- Temperature effects - Will the material maintain its protective integrity and flexibility under temperature extremes?
- Compatibility with other equipment - Does the clothing preclude the use of another necessary piece of protective equipment?
- Duration of use - Can required tasks be accomplished before contaminant breakthrough occurs or before degradation of the chemical protective clothing becomes significant.

DETAILS OF BENEFITS

- Disposable suits reduce the chance of skin contamination due to garment reuse. (Radiation monitoring after laundry is not 100% successful, and body moisture break-through is more easily detected using disposable suits--particularly the ProShield I.)
- The cost of the disposable suits was estimated to be less than the cost for the baseline suit.
- Less handling (e.g., collection, transportation, laundry, drying, radiation monitoring, and delivery) of the contaminated suits is required when using disposable suits.
- Disposable suits reduce account management (i.e., the cost of keeping a laundry subcontract).

SUCCESS CRITERIA

To understand the potential contribution of protective clothing to heat stress, the mechanism of body heat generation and dissipation must be considered. A requirement for normal body function is to maintain the deep-body temperature at approximately 37°C (98.6°F +/- 1.8 o F). To maintain thermal equilibrium, a constant exchange of heat between the body and the environment is required. The amount of heat that must be transferred from the body to the environment is a function of the following:

- Heat generated within the body (metabolic heat)
- The heat gained, if any, from the environment
- The type and number of layers of protective clothing worn
- The environmental conditions (e.g., air temperature, air velocity, and humidity).

A clothing system will alter the rate and amount of heat exchange between the skin and the ambient air by convection, radiation, and evaporation. When calculating the heat exchange by each or all of these routes, correction factors must be applied that reflect the type, amount, and characteristics of the clothing being worn when the clothing differs substantially (i.e., more than one layer, and/or greater air and vapor impermeability) from the customary one layer of clothing. Based on the C Reactor demonstration and the LANL assessments, the following observations were made:

- The Comfort Guard 150, Kappler NuFab, ProShield II, and Frham KoolSuit were chosen because each suit is advertised as breathable and water-resistant/waterproof (based on manufacturers data).
- All the suits have sewn seams, with the exception of the Frham KoolSuit and Nufab Suit (which are bounded seams).
- All suits were demonstrated to be essentially equivalent in tearability and level of comfort.

SCHEDULE

The following personnel protective suits were used in the personal protective equipment demonstration and assessments:

Los Alamos and Hanford:

Type of Suit	Dates	# of Suits Assessed	# of Suits Demo.
Frham KoolSuit	Jan. 1997	10	40
Pro Shield II	Mar. 1997	10	90
Comfort Guard 150	Oct. - Mar. 1997	10	4,000
Cotton	Oct. - Jan. 1997	10	500

Los Alamos only:

Type of Suit	Dates	# of Suits Assessed
NuFab Suit	May - Aug. 1997	10
Tyvek Suit	May - Aug. 1997	10

Hanford only:

Type of Suit	Dates	# of Suits Demo.
Pro Shield I	Mar. - Aug. 1997	3,000

FUTURE APPLICABILITY

Work areas to be considered are U.S. Department of Energy D&D sites; *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* remediation sites; and private industry where work is performed in contaminated areas. The suits can also be used for asbestos abatement.

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